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இலங்கைப் பரீட்சைத் திணைக்களம்
Department of Examinations, Sri Lanka

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2022(2023)
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2022(2023)
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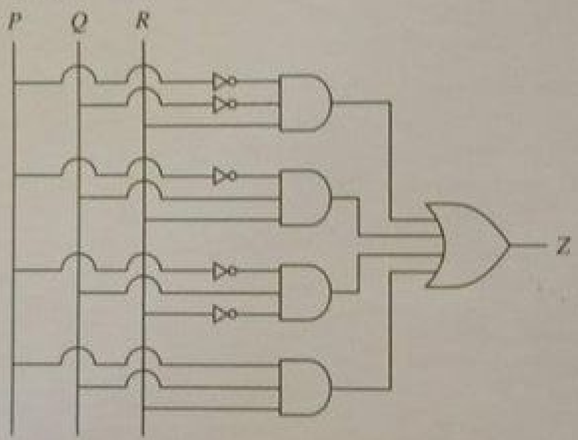
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தகவல், தொடர்பாடல் தொழினுட்பவியல் II
Information & Communication Technology II

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Part B

* *Answer any **four** questions only.*

5. (*a*) Consider the logic circuit shown in the following figure in which P, Q and R are the inputs and Z is the output.



(i) Draw the complete truth table for the above circuit.

(ii) Complete the Karnaugh map relevant to the above circuit according to the following format.

R \ PQ	00	01	11	10
0				
1				

(iii) Using the Karnaugh map, derive the most simplified sum-of-products expression for the output Z. Show the loops clearly on the Karnaugh map.

(*b*) (i) Using Boolean algebra, show that the Boolean expression $\overline{A}BC + A\overline{B}C + AB\overline{C} + ABC$ is equivalent to $BC + AC + AB$.

(ii) Draw a logic circuit for the above **simplified** expression in (*b*)(i) by only using OR and AND gates.

(iii) Draw a logic circuit for the above **simplified** expression in (*b*)(i) by only using NAND gates.

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6. (*a*) Write down the most suitable terms to replace the blanks labelled Ⓟ to Ⓤ in the following paragraph related to data encryption.

There are two types of encryption techniques used namely, *symmetric key encryption* and *asymmetric key encryption*. In ....Ⓟ.......... key encryption, the same key is used for encrypting and decrypting the information. In this scheme, to exchange information, users must share a ....Ⓠ.......... key among themselves. In ....Ⓡ.......... key encryption, different keys are used for encrypting and decrypting the information. In this technique, users usually have a pair of dissimilar keys known as a ....Ⓢ.......... key and a ....Ⓣ.......... key. When one key is used for encryption, the other key can decrypt the ....Ⓤ.......... back to the original plain text.

(*b*) Suppose that the ABC Company has received the 192.248.154.0/25 IP address block to be distributed among its four departments.

It is required to subnet the above IP address block to satisfy the following requirements. Assume that each department is located in a separate building.

Subnet Number	Department Name	Number of Computers
S001	Accounts	30
S002	Sales	28
S003	Service	18
S004	Administration	24

(i) Write the first address and the last address in the given address block.

(ii) Write the subnet mask of the given address block in dotted decimal notation.

(iii) How many host bits are needed to create the required number of subnets?

(iv) Once subnetting is done, fill the following table.

Subnet Number	Network Address	Subnet mask	First usable IP address	Last usable IP address	Broadcast Address
S001					
S002					
S003					
S004					

(*c*) (i) Write **one** difference between User Datagram Protocol (UDP) and Transmission Control Protocol (TCP) transport layer protocols.

(ii) Write **two** main functions of a router.

(*d*) (i) What is the functionality of a Domain Name System (DNS) server?

(ii) What is the functionality of a Dynamic Host Configuration Protocol (DHCP) server?

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7. (*a*) An IoT setup to water a plant in a greenhouse is shown in Figure 1. A mobile application is used to operate the water-releasing tap. As shown, the setup includes a sensor, a controller, and a microcontroller (Arduino Board) with a communication module.

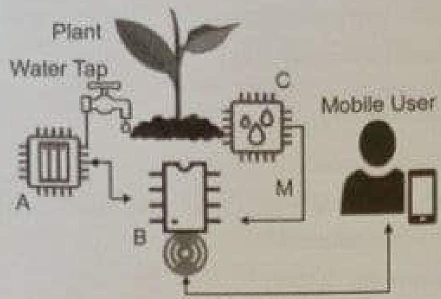


Figure 1

(i) Match the IoT components labelled as A, B and C to components described in the scenario.

(ii) Explain the reason why the arrow M is shown in a single direction.

(*b*) The moisture sensor provides 10 levels of moisture intensity with 1 being "the driest" and 10 being "the wettest"; 8 is the desired level to be maintained. The algorithm on the right can be used to automate the task of opening the tap when the soil is dry and to stop the water flow when enough watering is done. Write down the most suitable entries for the places labelled X, Y and Z. [**Note** – **While (true)** block represents the continuous loop function in Arduino]

```
While (true){
        Read Moisture Level as M_L
        If [X]
              If Tap Closed
                    Then [Y]
              End if
        Else
              If Not Tap Closed
                    Then [Z]
              End if
        End if
}
```

(*c*) What could be monitored in the greenhouse using an LDR sensor?

(*d*) A multi-agent system is proposed for this greenhouse (Figure 2). In this system the images that are captured using a mobile phone are stored in the plant database. The multi-agent system works as follows:

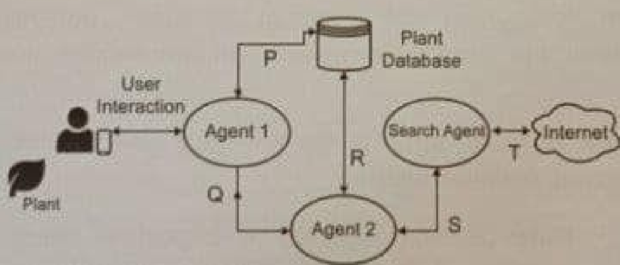


Figure 2

- Agent 1 handles the user interactions, user access to data, and triggers Agent 2.
- Agent 2 processes the images, identifies anomalies if any, and triggers Search Agent if needed.
- Search Agent searches relevant information from the Internet, feeds the search results to Agent 2 who updates the database after processing, and notifies Agent 1 if an alert is to be raised.

(i) In the given scenario, who is/are the self-autonomous agent(s)?

(ii) The interaction P involves saving plant details in the database and retrieving those for Agent 1. The interaction R involves reading the database and writing search results to the database. Explain the interactions Q and S.

(iii) After long-term use of the system, it was decided to remove Search Agent assuming that the database contains all the information needed. Write down the main disadvantage of this removal.

(*e*) The owner has started an online shop to sell the harvest from this greenhouse to buyers who are nearby.

(i) State **one** advantage of limiting sales to the community nearby the greenhouse.

(ii) State an alternative payment method that can be used until an online payment facility is setup.

(iii) He cultivated tomatoes and sells salted dried tomatoes online (as a snack). This, known as value addition, gives higher profits. Give another advantage of this value-addition to his e-business.

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8. (*a*) (i) What is the output of the following python script if 1002 is given as the input?

```
A = int(input("Enter a number:"))
B = 0
while(A > 0):
    C = A % 10
    B = B + C
    A = A // 10        # // is integer division
print(B)
```

(ii) What would be the modification required to the `B = B + C` code line of the above code if the reverse of a given positive number is to be printed?
(Example: if the input is 1234, the output should be 4321)

(*b*) Assume that your class is having a party, and each student is asked to bring one food item. The class teacher has decided to make the party interesting by introducing one rule: the first and last letters of the name of the food item must match with the first and last letters of the student name.

For example, ***percy*** is allowed to bring ***potato curry*** and ***prageeth*** is allowed to bring ***pepper fish***.

Write a Python function called Party() that takes the student name and the name of the food item as parameters. The function should return **True** or **False** to indicate whether the student is allowed to bring the food item to the party or not.

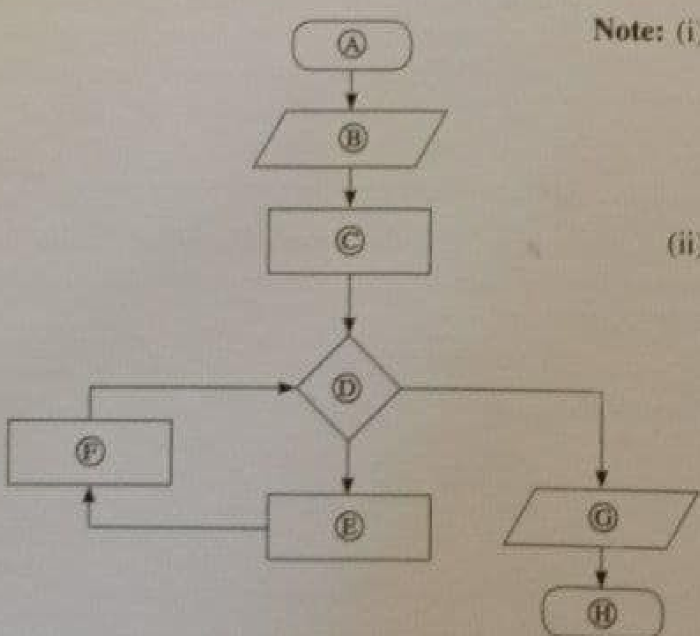
Example:

Party ("percy", "potato curry") should return **True**

Party ("fareena", "fried rice") should return **False**

Note: You can assume that student name and food item name are always lowercase strings and have at least two letters. There may be hyphens and spaces in the names, but these will not appear at the beginning or end of the string. The names will not contain numerals.

(*c*) Write down the most suitable statements for labels Ⓐ to Ⓗ in the flowchart given below which is drawn to calculate the factorial of a given positive integer.



Note: (i) The factorial of a positive integer is defined as the product of that integer and all the integers below it. E.g. factorial of 5 is $5 \times 4 \times 3 \times 2 \times 1 = 120$. The factorial of 0 is defined as 1.

(ii) A process box in this flowchart may contain one or more statements.

9. (a) Draw the Entity Relationship (ER) diagram for the following scenario.

A student uses the following data to register for subjects. Each subject is represented by its subject number (subjectNumber), subject name (subjectName) and prerequisite subject. A student can register for more than one subject during a semester. Each student has a first name (studentFname), a last name (studentLname) and a unique student number (studentId). Student age (age) is required to register for subjects. Subjects are offered based on the availability of the resources. Hence some subjects will not be offered during a semester. A subject offered in a semester (subject_offering) includes subjectNumber, year, semester, teacher identifier (teacherId), and classroom. One subject_offering is assigned to a single teacher who is represented by a teacherId, name of the teacher (teacherName), and qualifications. Teacher can have several qualifications. Marks are awarded to students for each subject that they register.

Use only the terms from the list given below for the entities and attributes in your ER diagram. You have the freedom to choose relationship names.

List : {age, classroom, DOB, marks, qualification, semester, student, studentFname, studentId, studentLname, subject, subject_offering, subjectName, subjectNumber, teacher, teacherId, teacherName, year}

Note: DOB – Date of Birth

(b) Use the following **Employee**, and **Assign_Project** denormalized tables to answer parts (i), (ii), (iii), (iv) and (v). Please note that primary key(s) of each table is(are) underlined.

Employee

EmployeeId	FullName	DOB	Salary
E001	Saman Perera	12/02/1978	140000
E002	Upul Fernando	23/05/1982	44000
E005	Chris Peris	11/08/1980	44000
E007	Kamala Gamage	08/08/1973	52000
E008	Sunil Perera	25/04/1969	115000
E011	Vipul Namal	09/02/1977	38000

Assign_Project

ProjectId	EmployeeId	PName	Description
P04	E002	Sales	Implement sales management system
P04	E008	Sales	Implement sales management system
P06	E007	HRM	Implement HRM system
P07	E002	Library	Implement library management system
P09	E001	Inventory	Implement inventory management system
P09	E007	Inventory	Implement inventory management system

(i) Write down the output of the following SQL statement:

```
SELECT Employee.FullName, Employee.Salary
FROM Employee, Assign_Project
WHERE Assign_Project.EmployeeId = Employee.EmployeeId;
```

(ii) Write an SQL statement to display the names of the employees who are assigned to project **P04**.

(iii) In which normal form does the **Assign_Project** table exist?

(iv) What needs to be done to convert the **Assign_Project** table into its next normal form? Justify your answer.

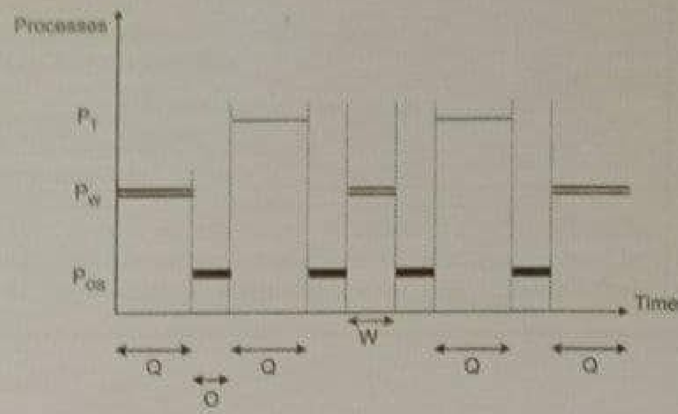
(v) Give an example SQL query where the update anomaly can occur in **Assign_Project** table.

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10. (a) A user starts a web browser on her single processor computer to go through some Python tutorials. She also starts a text editor to work on her Python program.

The diagram shows how the *web browser* (P_W) and the *text editor* (P_T) processes run on the processor along with the *operating system* (P_{OS}) since the time the user started the web browser.

What important work related to P_W and P_T will be performed by the operating system during the time period indicated by 'O'?



(b) Assume that the time period the operating system allocates to each process to run on the processor in a single instance is Q.

Explain why W (the time period the web browser process runs at the second instance) is less than Q as shown in the graph.

(c) Assume that we have a computer that can use 16-bit virtual addresses from 0 up to 64 K. Assume further that this computer has only 32 KB of physical memory and that the page size in this computer is 4 KB.

The above 16-bit virtual address is made up of the *bits of the page number* followed by *offset bits*.

User runs a particular program having a size of 32 KB on this computer. A few selected fields of the page table of that process at a particular time are shown in the figure below.

Page number	Frame number	Present/ absent
0	011	1
1	101	1
2	000	0
3	000	0
4	000	0
5	000	0
6	000	0
7	000	0

Notes:

- The frame number is indicated in binary.
- The virtual addresses on page 0 are from 0 to 4095 and on page 1 are from 4096 to 8191 and so on.
- The Present/absent bit indicates the validity of the entry. If this bit is 1, the entry is valid and can be used. If it is 0, then the relevant virtual page is not in physical memory.

Assume that in the above process the virtual address 0001 0000 0000 0011 is wanted. Is that page available in physical memory? If your answer is 'yes', then write down the 15-bit physical address that the above virtual address will be mapped into. If your answer is 'no', then write down the actions that the operating system will take on behalf of that process for the said requirement.

(d) Give **two** reasons as to why a page of a process may not be in physical memory.

(e) Explain how the operating system could find the blocks of a file when the files are stored on a hard disk using

(i) contiguous allocation and

(ii) index allocation.

(**Hint:** the use of the directory entry)

* * *